Review Article

# Fluoridation Under Fire: Health Risks or Benefits to Public Health?

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**Abstract**

Fluoridation of public water supplies, aimed at reducing tooth decay, has been a contentious issue for decades. While its effectiveness in improving dental health is acknowledged, there is growing debate over its necessity. The U.S. Environmental Protection Agency (EPA) has announced a review of new scientific findings, particularly following a 2024 National Toxicology Program report suggesting that fluoride levels above 1.5 mg/L may lower IQ in children. Policy responses vary internationally: the U.K. plans to expand fluoridation, while Ireland currently has the highest coverage in Europe. Despite diminishing benefits from fluoridated water as fluoride toothpaste has become widespread, data still indicates a reduction in dental cavities, with socioeconomic factors playing a larger role in oral health outcomes. The risks of dental fluorosis and potential developmental neurotoxicity at high fluoride levels are also concerns. Even more, the ethical issue of public water fluoridation overriding personal choice is central to the debate, particularly when alternatives like fluoride toothpaste are widely available. The complex relationship between fluoride levels, public health, and individual autonomy continues to fuel the need for further research.

**Keywords**

Fluoridation; Fluoride toxicity; Public health; Dental fluorosis; Drinking water standards; Mass medication ethics.

## 1 Introduction

Fluoridation is the process of adding fluoride to public water supplies in order to reduce tooth decay. While this strategy is effective, there has been a longstanding debate regarding its necessity. The U.S. Public Health Service previously recommended an optimal fluoride level of 0.7 to 1.2 mg/L, but later revised this downward to 0.7 mg/L. Based on 2022 figures, 62.8% of the U.S. population receives fluoridated water [1]. The U.S. Health Secretary Robert F. Kennedy Jr. called for an end to the practice altogether in the United States following its recent ban in the state of Utah. The ban was enacted due to concerns about potential health risks and the ethics of mass medication without individual consent [2].

Amid the ongoing debate, the U.S. Environmental Protection Agency (EPA) announced that it will conduct a comprehensive review of new scientific findings on the potential health risks of fluoride added to public drinking water. This decision was prompted by an August 2024 report from the National Toxicology Program, which suggests that fluoride levels above 1.5 milligrams per litre could be associated with lower IQ in children. The EPA aims to assess these findings and conduct additional studies to update its health effects assessment and potentially revise the fluoride drinking water standard [3].

Worldwide, fluoridation practices vary significantly. While countries like the United States, Australia, and Ireland have widespread water fluoridation programs, most European nations have opted against this practice. Only Ireland and the United Kingdom currently add fluoride to public water supplies in Europe, with the majority of European countries choosing alternative approaches to dental health.

## 2 Discussion

While most European nations have opted against water fluoridation, the United Kingdom is taking a different approach by deciding to expand its program, which has been in place since the 1960s [4]. Looking at coverage rates more specifically, Ireland stands out in Europe with 71% of its population receiving fluoridated water, compared to 10% in the United Kingdom [5–7]. Fluoride concentrations also vary between countries: Ireland targets 0.7 mg/L with an optimal level

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between 0.6–0.8 mg/L [5] while the UK aims for around 1.0 mg/L with an upper limit of 1.5 mg/L [8]. Spain, which had region-specific fluoridation programs, has stopped the practice altogether with the Basque country having phased out artificial fluoridation of public water supplies in 2021. The decision was based on ethical concerns over its mandatory nature, particularly given that children already benefit from free dental care programs, and given the widespread use of fluoride toothpaste [9–11]. This contrasts with the United States, where 62.8% of the population has access to fluoridated water, with a national target level of 0.7 mg/L.

Naturally occurring fluoride in drinking water varies around the globe, Africa has the highest groundwater fluoride levels, followed by Australia/Oceania and South America, with Asia and North America at lower levels, and Europe being the least affected [12].

While the effectiveness of fluoridation in reducing dental cavities is widely accepted, an updated Cochrane review shows that the dental health benefits of water fluoridation have diminished since fluoride toothpaste became widely available in the 1970s. While water fluoridation might improve oral health marginally, it does not address broader issues like sugar consumption or oral hygiene [13]. A questions and answers page by the European Commission sheds further doubts on fluoridation of public water services by stating that "there is no obvious advantage in favour of water fluoridation compared with topical application, that is via toothpaste, mouthwash or gel" [14].

Nonetheless, fluoridation does decrease dental cavities as measured by decayed, missing and filled teeth (DMFT), as can be seen by comparing DMFT scores in parts of Ireland with fluoridated water and those without (Fig. 1). Interestingly, countries with higher GDP per capita have comparable DMFT scores despite the moderate difference that can be associated with fluoridation. A larger difference exists between countries with higher GDP per capita and those with lower GDP per capita, such as those in Eastern Europe (Figs. 1 and 2). This indicates that socioeconomic factors may play a more important role than the fluoridation of public water supplies. Moreover, historical data indicate that DMFT scores have also generally improved over time regardless of public water fluoridation. This trend has occurred in parallel with a steadily rising standard of living across the EU [15].

The World Health Organization (WHO) recommends a maximum of 1.5 mg/L for drinking water, a value that is higher than the typical 0.5–1.0 mg/L recommended for artificial fluoridation of water supplies [18]. Concentrations exceeding this limit are associated with an increased risk of dental fluorosis, particularly in children under the age of eight. Dental fluorosis is a cosmetic condition characterized by white spots, and in more severe cases, brown staining and pitting of the enamel, the hard, outer surface of the tooth that protects it from decay. Chronic fluoride intake above 6 mg per day can result in debilitating skeletal fluorosis.

The EU Scientific Committee on Health and Environmental Risks (SCHER) reviewed the health effects of fluoride following systemic exposure through drinking water. Besides the well-established risk of dental and skeletal fluorosis, the committee cited epidemiological studies suggesting carcinogenicity, developmental neurotoxicity, and reproductive toxicity. However, when evaluated using a weight-of-evidence approach, the committee could not support these findings [19].

In 2024, the US National Toxicology Program (NTP) conducted a systematic review examining fluoride exposure and its potential effects on neurodevelopment and cognition. The review found, with moderate confidence, that concentrations of fluoride in drinking water above 1.5 mg/L are associated with reduced IQ in children. This finding is based primarily on epidemiological studies conducted outside the United States. The review also referred to a meta-analysis that reported a significant decrease in IQ of 1.63 points per 1-mg/L

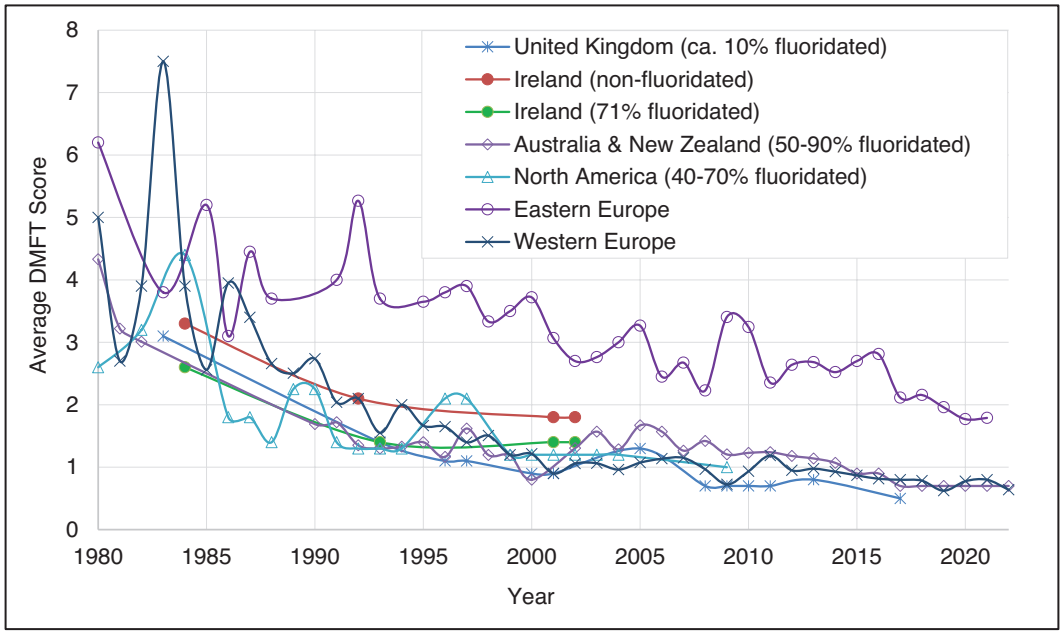


**Fig. 1: DMFT score (decayed, missing and filled teeth) for permanent teeth among 12-year-olds in EU countries in addition to, for comparison, the United Kingdom, USA, Canada, Australia and New Zealand. Eastern Europe: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia. Western Europe: Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Italy, Luxembourg, Malta, Netherlands, Portugal, Spain, Sweden. North America (40-70% fluoridated): USA (ca. 70% fluoridated), Canada (ca. 40% fluoridated). Australia & New Zealand (50-90% fluoridated): Australia (ca. 90% fluoridated), New Zealand (ca. 50% fluoridated). Data retrieved from the Oral Health "Country/Area Profile Programme" (CAPP) database, Malmö University [16].**

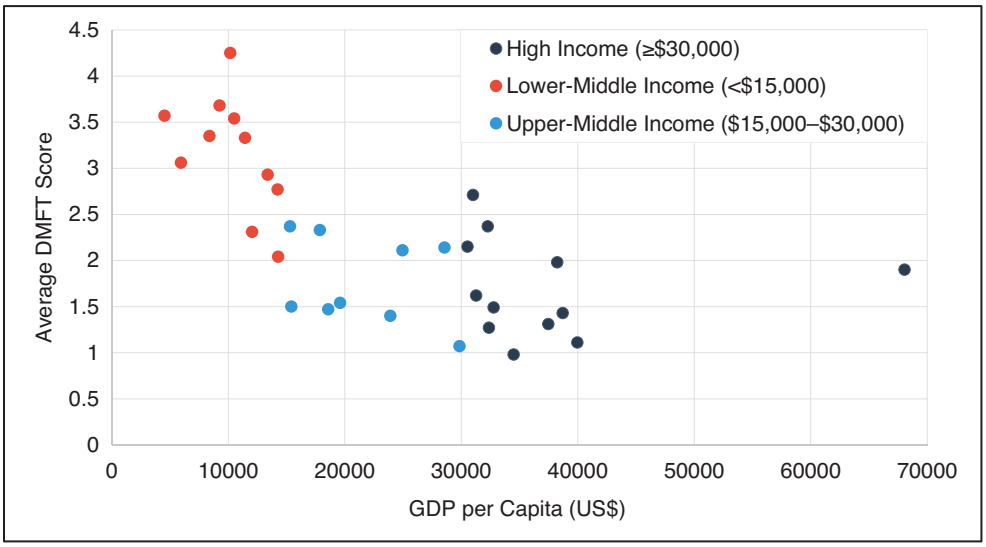


**Fig. 2: Average DMFT scores per country from the CAPP database plotted against average World Bank estimates for GDP per capita for the period 1980-2022 [17]. Pearson Correlation Coefficient: -0.637 (moderate-to-strong negative correlation). Income groupings are based on modified GDP per capita thresholds (US$) to better reflect relative economic differences between Eastern Europe, Western Europe, North America, Australia and New Zealand: lower-middle (<$15,000), upper-middle ($15,000–$30,000), and high income (≥$30,000).**

increase in urinary fluoride. The evidence was insufficient to assess whether lower fluoride levels, such as the 0.7 mg/L recommended for U.S. community water systems, have any impact on children's IQ. No adverse effects on adult cognitive function were identified. Importantly, the review highlights that the observed association does not establish causation and that further research is needed, particularly at lower exposure levels [20].

Perhaps the most poignant point raised by opponents of fluoridation relates to the freedom of choice. They argue that fluoridation violates individual choice by medicating water supplies without consent. This raises ethical questions about balancing public health benefits against personal autonomy, particularly when alternatives like fluoride toothpaste are widely available. A report by the Dutch National Institute for Public Health and Environment (RIVM) looking into cost-effective preventive interventions summed it up by stating that "fluoridation of drinking water would conflict with the freedom to choose for natural drinking water. This principle of freedom of choice is considered as an important basic principle in the Netherlands."

## 3 Conclusion

While fluoridation of public water supplies has proven effective in reducing dental cavities, its necessity and ethical implications remain a topic of significant debate. The growing body of scientific evidence, including concerns over potential health risks such as reduced IQ in children at higher fluoride levels, has prompted calls for re-evaluation of current practices. Furthermore, the availability of alternatives like fluoride toothpaste and the role of socioeconomic factors in dental health suggest that fluoridation may no longer be as crucial as it once was. The ongoing discussions surrounding public health, individual choice, and the balance between these interests highlight the complexity of the issue. Moving forward, more research will be essential in determining the future of water fluoridation policies, ensuring that public health benefits are maximized while respecting personal autonomy.

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